

# Transplanckian Axion Monodromy !?

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José Calderón Infante

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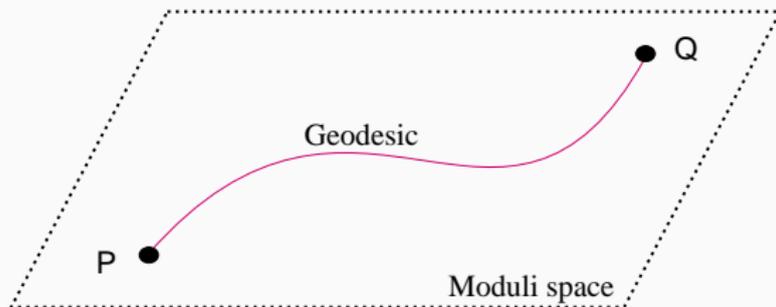
Instituto de Física Teórica (UAM/CSIC)



Based on: 1812.05016

in collaboration with Ginevra Buratti and Ángel Uranga.

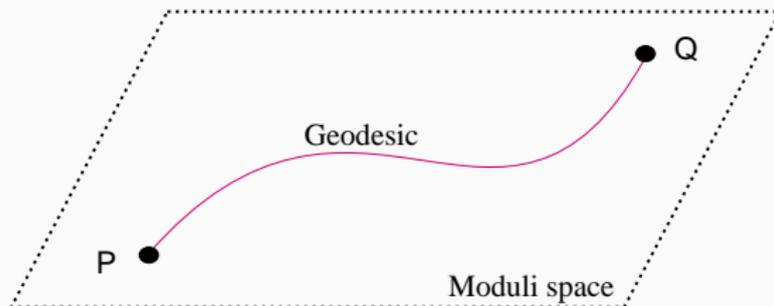
# Motivation



- SDC:  $\frac{m(P)}{m(Q)} \rightarrow e^{-\alpha\Delta(P,Q)}$  as  $\Delta(P,Q) \rightarrow \infty$  ( $\alpha > 0$ ). [Ooguri,Vafa]
- RSDC: Exponential behavior at least valid for  $\Delta(P,Q) > 1$  and  $\alpha \sim \mathcal{O}(1)$  (in Planck units). [Kläwer,Palti]

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*Transplanckian field ranges are not physically attainable in Quantum Gravity (?)*

## Claim of the paper

*KS-like throats describe **fully backreacted** axion monodromy models in which the axion **physically rolls** through transplanckian distances !!*

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- Fully backreacted
  - Usual argument against transplanckian axion monodromy.  
[Baume,Palti]
- Physically rolls
  - The axion has some spatial dependence, **not adiabatic**.

KS solution and transplanckian axion monodromy

Effective field theory analysis

Conclusion

# KS solution and transplanckian axion monodromy

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# Type IIB Freund-Rubin $AdS_5 \times T^{1,1}$ background and the axion

1. Compactification ansatz:

$$ds_{10}^2 = \frac{r^2}{R^2} \eta_{\mu\nu} dx^\mu dx^\nu + R^2 \frac{dr^2}{r^2} + R^2 ds_{T^{1,1}}^2$$

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About the compactification space...

$\rightarrow T^{1,1}$  is topologically  $S^2 \times S^3 \implies \boxed{\phi = \int_{S^2} B_2}$  **Axion!**

As an axion,  $\phi$  has a discrete shift symmetry:  $\phi \sim \phi + 1$

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Dvali-Kaloper-Sorbo term!

[Dvali][Kaloper, Sorbo]

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**Disclaimer:** This is KT solution, which is the large  $r$  limit of KS.

# Transplanckian excursion of the axion

Distance in field space:

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Together with the rolling of the axion gives

$$\Delta \sim (\log r)^{1/2} \text{ Transplanckian distance!}$$

# Effective field theory analysis

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# Effective 5d action

In KT paper [Klebanov, Tseytlin] they use an effective 5d action to get the solution. We check that:

$$G_{\phi\phi} \sim R^{-4} \rightarrow \text{Transplankian distance!}$$
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**BUT!**  $m_{KK} \sim m_R$

$\implies$  This is not an EFT in the Wilsonian sense!

... Only a consistent truncation of the 10d dynamics.

# Integrating out the breathing mode

Luckily, we can save the day!

$$\delta\phi \ll m_R \sim m_{KK} \rightarrow \text{We can integrate out R!}$$

Doing so...

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✓ EFT describing the transplanckian excursion!

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Main suspects: KK modes

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✓ No tower of exponentially light states!

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✓ Nothing to do with RSDC

## Conclusion

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*Transplanckian field ranges are physically  
attainable in Quantum Gravity!*

Thanks for your attention!

Backup slides

## Hierarchy between $\{\phi, \Phi\}$ and $\{R, \phi\}$

Potential in the full 5d EFT:

$$V = e^{-8q} (e^{-12f} - 6e^{-2f}) + \frac{1}{8} M^2 e^{\Phi+4f-14q} + \frac{1}{8} (N_0 + M\phi)^2 e^{-20q}$$

For  $M = 0$ , both  $\Phi$  and  $\phi$  does not appear in it, while  $q$  and  $f$  are stabilized.

Considering  $M$  as a deformation of the pure  $AdS_5 \times T^{1,1}$  case ( $N \gg M$ ):

→  $q$  and  $f$  are heavy modes!

→  $\Phi$  and  $\phi$  are light!

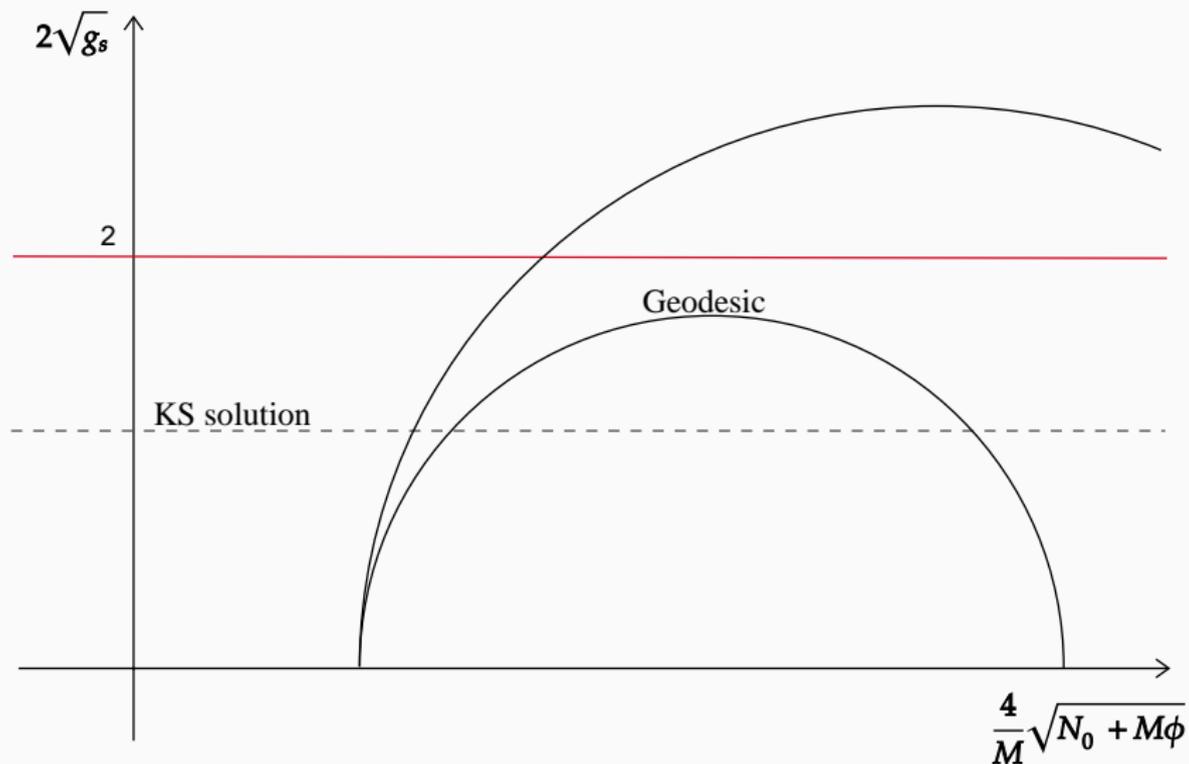
## Hierarchy between $\{\phi, \Phi\}$ and $\{R, \phi\}$

But... What if  $M \not\ll N$ ?

1. For large  $r$ ,  $\phi \gg 1$  so the axion has traveled its period many times.
2. Due to the monodromy, each time the axion cross its period  
 $N \rightarrow N + M$ .

$\implies$  For large  $r$  we can always interpret  $N \gg M$ .

# RSDC in $\{\phi, \Phi\}$ moduli space



## RSDC in $\{\phi, \Phi\}$ moduli space

- Vertical lines:

$$\Delta \sim -\frac{1}{2} \ln(y) \sim -\frac{1}{2} \ln(2\sqrt{g_s})$$
$$\implies g_s \sim e^{-2\Delta}$$

- Semicircumference:

$$\Delta \sim -\frac{1}{2} \ln(\tan(\alpha/2)) \sim -\frac{1}{2} \ln\left(\frac{y}{2R}\right) \sim -\frac{1}{2} \ln\left(\frac{\sqrt{g_s}}{R}\right)$$
$$\implies g_s \sim e^{-2\Delta}$$

In both cases we get a tower of stringy states becoming exponentially light satisfying the RSDC!